number of segments per a given projector length. Thus, there is a need for an improved projector construction and method of manufacture which reduces assembly labor costs and reduces the number of parts for each projector, which reduces or eliminates dynamic loading on the projector and shell sheer stress for a given design, thereby increasing the depth capability and dynamic range of the projector.

Summary of Invention

Some examples of slotted shell prior art acoustic projectors are shown in US Patent Nos. 5,020,035; 5,122,992; 5,592,359; 6,491,095; and 4,220,887. Some examples of non-slotted acoustic projectors are shown in US Patent Nos. 5,926,439; 6,535,459; 6,545,949; and 6,567,343.

To solve this problem the acoustic projector of the present invention can be assembled in a "super segment" method with multiple drivers as part of a shell segment. This not only stiffens the longitudinal assembly but also reduces the number of segments for interactions to occur. The goal is to reduce the number of segments to 2 segments. If this is not possible then an even number of segments is needed. This solution solves interactions in the slotted cylinder projector, however this technique can be used in other transducer technologies.

The most significant advantage to the new constructions method is, multiple drivers in one shell segment which stiffens the shell segments in the longitudinal length direction and reduces longitudinal vibrations modes as well as significantly reduces acoustic segment interactions, usually caused by hydrodynamic load variations along the length. The new method and acoustic projector construction is also not constrained by the manufacturable length of the drive material. The shell segment can be any length and multiple drivers can be assembled inside one shell segment. Additionally, this

Detailed Description of the Preferred Embodiment

The most significant advantage to the new projector construction and method of the present invention is the use of multiple drivers in one shell segment which stiffens the shell segments in the length direction and reduces longitudinal vibration modes as well as significantly reduces acoustic segment interactions, usually caused by hydrodynamic load variations along the length. The new projector construction and method also is not constrained by the manufacturable length of the drive material. The shell segment can be any length and multiple drivers can be assembled inside one shell segment. Additionally, this projector construction and method is more cost effective and faster to assemble due to the reduced number of parts and pieces that need to be purchased or handled. Also the designer can use this construction and method to ensure that the projector is designed with one or two shell segments, which is the optimum segment number(s) to eliminate segment interactions. If one or two segments can't be used then the designer has the flexibility to ensure an even number of shell segments can be used and any interactions can be managed via wiring, tuning, or shading methods.

The single shell of the multiple driver shell segment forces the drivers to move more closely in unison than if the segments were one shell per driver. Another prior art was to bond, pin, or epoxy single drive/shell segments as to approximate the large single shell with multiple drivers. This construction and method has been used but has several inherent flaws. The epoxy/pinning mechanisms used are never as strong as a single shell. Combined with the tremendous forces that are exerted during drive and interaction, failure is almost assured. However, the single shell multiple drivers reduces the interaction, and thus reduces the shear forces. Also, the single shell is significantly strong in the shear direction to handle any interaction forces that might

concept of the invention. Arcuate segments 16 assists in retaining drivers 10 within shell segment 8. Various types of a bonding adhesive or caulking material can also be used to secure drivers 10 within shell segment 8.

Preferably, the combined longitudinal lengths of drivers 10 will be between 70% and 90% of the longitudinal length of shell segment 8. This has been found to provide the most satisfactory results, both from the acoustic properties, as well as the strength of the assembled projector. A thin layer of insulation 20, preferably will be located between shell 8 and driver 10 to ensure the electrical integrity of the drivers even though outer shell 8 preferably will be formed of a dielectric material such as an epoxy graphite composition, fiberglass, a ceramic, or the like. However, shell 8 can be formed of various types of conductive materials, such as metal and separated from drivers 10 by an insulation layer 20.

However, in accordance with the invention, at least two drivers 10 are mounted within a single shell segment 8, or for certain applications, an even number of drivers, for example, 4, 6, or 8, etc. could be mounted within a single shell segment. This reduces the sheer stress and dynamic loading on the shell thereby increasing the depth capability and dynamic range of projector 1.

A modified form or extension of the present invention is indicated generally at 22, and shown in Fig. 3. Embodiment 22 consists of a pair of shell segments 8, and as discussed above, each segment 8 containing a pair of drivers 10, which segments are joined together to provide a multiple shell segment, each containing multiple drivers. The remaining construction of projector 22 is similar to that described with respect to shell 8 and driver 10. The shell segments preferably are longitudinally joined by a lower alignment pin 24 (Fig. 4) with various types of epoxies or glues at their mating edges.